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Comparing the Performance of the Expected Returns of Cryptocurrencies Using CAPM and D-CAPM Approaches

Abstract: - The present study compares the expected returns of cryptocurrencies using the capital asset pricing and the downside capital asset pricing models. For this purpose, fifty cryptocurrencies were studied as representative of risky assets during the five-year from 2018 to 2022 with daily frequency. Using the conditional variance test, eighteen cryptocurrencies were accepted and the rest were homogeneously rejected in the variance heterogeneity test. Among the eighteen cryptocurrencies, nine were randomly selected as the portfolio, including high-volatility, low-volatility, and medium-volatility cryptocurrencies. First, using the t-Student statistic, the total return and downside return were compared. Results showed that the capital asset pricing model and the downside risk asset pricing model can be fitted in cryptocurrencies. Using the Wald-Fisher model, we investigated the justification for selecting a more appropriate model based on downside returns. The results of the research showed that D-CAPM and CAPM show the relationship between risk and return in cryptocurrencies appropriately, and the portfolios obtained from the mentioned models show the efficiency of the two models in the cryptocurrency market.

Keywords: Cryptocurrency, Capital Asset Pricing Model (CAPM), Downside Capital Asset Pricing Model (D-CAPM)

I. INTRODUCTION

Attempts to explain the relationship between risk and return and the pricing of securities and, accordingly, predicting the expected return have a long history in financial knowledge (Ayboğa MH, et al., 2022; Ngoc HD, et al., 2022). It is one of the most significant issues facing investors. One of the most useful models in risk assessment is the capital asset pricing model, which predicts the expected return of assets by calculating the systematic risk of assets. Many financial theories such as CAPM are based on the mean variance behavior, which requires considering the existence of symmetrical and normal distribution of returns. In this framework, the volatility of returns around the mean is defined as risk. It has been extensively considered by investors (Sadovnikova N, et al., 2022; Mirghaed MT, et al., 2022). However, significant shortcomings have been introduced to it. The results of many studies in developed markets indicate that investors put more emphasis on preserving capital than earning a profit, and in their utility function, the loss is more significant than profit. They tend to evaluate the effect of systematic risk in the negative risk direction on the return of your investment. Also, in some cases, stock returns did not have a normal distribution.

Accordingly, criteria based on downside risk are defined, which is based on the assumption of asymmetry of returns and different reactions of investors to low and high volatilities in the mean. In this framework, it is believed that investors consider low-mean volatilities as risk and high-volatilities as opportunities and give priority to preserving the principal of the capital compared to earning profit. Cryptocurrency is a digital asset designed as a decentralized currency between users using cryptography. It can be concluded that digital currencies are different monetary currencies, such as the US dollar and euro, which have a significant function, to be traded for something. This is the purpose of Bitcoin. However, there are hundreds and thousands of altcoins (alternatives to bitcoin) that have very different functions.

Most of the altcoins are just projects or ideas, but they still have many followers and supporters. For some, coins are just a small part of their plan. All coins and tokens are defined as cryptocurrencies, although some of them do not function as currencies. Thus, all cryptocurrencies are not traded as a currency in everyday use (Harjunpaa, 2017). Among financial asset classes, Bitcoin has emerged as the most popular digital financial asset. It has attracted the attention of market participants and researchers (An & Rau, 2019; Momtaz, 2019; Shi & Shi, 2019). It has also been extensively used as an alternative to traditional currencies to facilitate trade between criminals, fraudsters, and money launderers (Ju et al., 2016). However, Bitcoin is increasingly used for speculation rather than trading. Recent evidence suggests that seventy-three percent of bitcoins are held in inactive accounts, which

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supports this view (Bohme et al., 2015; Weber, 2016). One of the oldest questions of financial econometrics is whether the prices of financial assets are predictable. In other words, modern financial economics is primarily an attempt to "beat the market". This attempt is still debated in journal articles, conferences, and meetings (Campbell et al., 1997).

The objective of this study is to examine the accuracy of the CAPM model and the D-CAPM model in predicting the expected rate of return of cryptocurrencies. Very limited studies have directly investigated the predictors of Bitcoin return rates and predictors that can provide a profitable trading strategy. Bitcoin block size and mined rate of return may create profitable trading strategies. Given the fundamental valuation techniques used to determine the intrinsic value of Bitcoin, market participants should rely strongly on alternative tools to predict the price of Bitcoin, such as technical analysis (Jang & Lee, 2017). The indicators suggested in this study to select a digital currency portfolio are as follows:

-Selecting the digital currencies that have the largest market share and the exchange value of these currencies is more than one billion dollars.

-Selecting among ten types of digital currencies according to the study of correlation between them leading to risk management and the possibility of tracking their price volatilities

-Selecting the currencies that are market leaders

Selecting the currencies that use high-security conditions and fast transfer in the network and provide new services to attract investors

In this study, using the results of a study by Estrada, Fama, and Ferench, we compare the CAPM multi-factor model and the D-CAPM multi-factor model in 18 highly traded cryptocurrencies (such as Bitcoin, Ethereum, Ripple, Binance, DOGE, Cardano, ...). The portfolios include nine cryptocurrencies (2018-2022) in terms of transactions (high transactions and low transactions to obtain the mean return of the cryptocurrency market (cryptocurrency market index). We used R software to analyze the data.

Theoretical literature and review of research background

Theoretical literature

Portfolio optimization

Investors were looking for securities that were undervalued before 1952. They did not pay attention to the relationship of that security with other securities in the portfolio. Markowitz (1952) stated that if investors consider investment risk as an unfavorable factor, the effect of the diversification of assets on the return and risk of investment and their relationship with each other in a set of stocks that is below the intrinsic value should be considered significant. Accordingly, he presented his model for selecting the optimal portfolio based on mean-variance and return. Some of the most significant assumptions of his model are the risk aversion of the investors, the incremental expected total utility with negative marginal utility at a certain level of risk, selecting the highest return and at a certain level of return, selecting the least risk based on the level of risk aversion, and the slope of the investors' utility curves.

Capital asset pricing model

It is an equilibrium model developed by Sharpe based on the Markowitz portfolio model. The essential assumptions of this theory are homogeneous expectations, a complete competition market, and the existence of the same risk-free borrowing and lending rates. Based on this model, the investor will select his optimal portfolio from the combination of two assets, the risk-free asset and the market portfolio. In the capital asset pricing model, the variability of an asset's return compared to the variability of the market portfolio's return is considered a risk.

Traditional CAPM is a static model of portfolio allocation under conditions of uncertainty and risk aversion. As Bradley and Myers (1981), Fama (1976), and other existing literature show, this model relates the return Ri of asset i to the risk-free asset return Rf and the market return Rm. It can be shown mathematically as follows:

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$$E[R_i] = R_f + \beta_{m_i}\left(E[R_m] - R_f\right) + e$$

Here, E is the expected indicator or mathematical expectation, and the market beta is:

$$\beta_{m_i} = \frac{COV(R_i, R_m)}{VAR(R_m)}$$

Where the term $\beta_{m_i}$is the systematic risk measure of asset i.

The goal of many models of the CAPM is identifying the determining factors in differences in the expected returns of different assets. However, some models answer this question with a doubt, while others do it definitely. The family of capital asset pricing models originates from four primary assumptions developed independently by economists Trainver (1962), Sharpe (1964), Lintner (1965), and Myosin (1966). The framework of the model is based on mean-variance and Sharpe received the Nobel Prize in Economics in 1990 for it. CAPM uses historical asset prices and market portfolios to calculate beta in different periods. It is done by simply calculating the slope of historical price changes with portfolio percentage changes and using the value of this slope in the CAPM formula.

The CAPM model includes 4 assumptions:

1-Taxes and transaction fees are not considered

2- Investors can borrow or lend money without interest rate risk

3-There is no perfect capital market

4- Investors are only worried about expected returns.

Downside capital asset pricing model

Estrada (2002) introduced the D-CAPM model based on negative market risk in asymmetric conditions. In this model, the investor's utility is calculated from the$U \sim (\mu_P, \sum_P^2)$ equation. The variable$\sum_P^2$ is the negative variance of the investment return (pseudo-variance) and the variable μP is the mean return of the investor. In this framework, the risk of the asset i is calculated separately through the negative return of standard asset changes or pseudo-variance. This is a generalized model of the capital asset pricing model, which uses dβ instead of β in the model (Estrada, 2002).

^{d} =Semi cov(R_i ,R_M)⁄Semi var (R_M)β

The rate of return based on the daily price is calculated discretely based on the above equation: $R_{i,t}$ is the return on asset I at time t and $P_{i,t}$ is the price of the asset i on the day t. (Raei & Saeidi, 2004).

$$R_t = \frac{P_t}{P_{t-1}}$$

Literature review

Foreign literature review

Harry Markowitz (1959) tried to help investors select their optimal portfolio from the set of risky assets available in the capital market. William Sharpe presented the CAPM model or capital asset pricing model in 1964. After four decades since the life of the CAPM model, it is the most widely used model in various fields of financial management and investment. However, experimental studies indicated that this model, in which the expected return is affected by beta, has low potential to explain and interpret stock returns. This doubt led to efforts to develop a more efficient model. Estrada invented a model called the downside capital asset pricing model or the D-CAPM model in 2002 that can be an appropriate estimate of the expected return in asymmetric market conditions. He stated that capital assets up to 38% and adjusted capital asset pricing up to 55% provide a suitable estimate of the expected return in asymmetric market pricing conditions (Rahnemay-e Roodposhti, Nikoo Maram, & Shahverdiani, 2006).

Due to the lack of approval of the law related to cryptocurrency transactions in financial institutions, no research has been conducted so far in the area of calculations related to comparing the efficiency of CAPM and D-CAPM models in measuring the expected returns of cryptocurrencies. In foreign studies, the challenges facing Bitcoin include the challenges of banking system legislation, creating confidence for people, changing people's habits to use Bitcoin, and the costly nature of Bitcoin mining. Bitcoin transactions have no boundaries and they are not subject to sanctions and can increase the national gross domestic product, especially in the export sector. Also, Bitcoin can account for a significant share of liquidity in the future (Parsons & Louise, 2016).

Due to the shortcomings in CAPM, in the second half of the 20th century, many tests were conducted on the reliability and stability of systematic risk under different market conditions, which was the most significant factor in the development of the D-CAPM model. However, some criticisms were reported on this method of measurement, especially in asymmetric market conditions since there was an inability to show upward and downward changes in return and poor performance of beta coefficient and CAPM in some economic conditions of the market. The concept of negative risk (the most significant factor in the development of the D-CAPM model) was proposed after the 1950s by Roy (1952) and Markowitz (1959). However, in the 1970s when balanced asset pricing models along with risk negative was proposed, the concept of negative risk was considered by financial and management experts. The first work in this regard was done by Levi (1974). Then, researchers such as Hogan and Warren (1974), Bava and Lindenberg (1977), and Harlow and Rao proposed pseudo-CAPM models based on negative risk criteria.

Cross and Lisenberger (1976) proposed a method to respond to upward and downward changes in returns in asymmetric market conditions. Then, Bava and Lindenberg (1977) examined gradual downward changes in the asymmetric conditions of the market and concluded that independent asset risk can be better achieved using gradual downward changes. In the same year, Fabozzi and Francis tested beta stability in five upward and downward markets. With the development of negative risk, Huang and Satchell (1999) and Hervey and Sidku (2000) showed that if the pricing model was used together with negative risk, the new model showed a much better performance compared to the previous models in the American financial markets.

Also, Ange, Chen, and Xing (2001) extended downward gradual changes and obtained a stock risk-reducing factor in the US financial market that could estimate a cross-sectional rate of return. Estrada invented a model called the "Downside Capital Asset Pricing Model" from 2000 to 2002. It could provide an appropriate estimate of the expected return in asymmetric market conditions. He believed that in asymmetric market conditions, CAPM provides an estimate of up to thirty-eight percent and D-CAPM up to fifty-five percent of the expected return. Also, Pederson, Huang, and Weiman (2003) concluded that βD provides a more appropriate estimate of the expected rate of return in the asymmetric market compared to β. A study conducted in British companies revealed that βD is 15 to 25% higher than β and D-CAPM has more capability compared to CAPM to estimate the expected rate of return (Yousfi Mohammad Gholi et al. 2009).

Reddy and Clinton (2016) conducted a study entitled simulating stock prices using the geometric Brownian motion model in Australian companies. They simulated the path of stock prices using the geometric Brownian motion model. In this study, they examined the Australian companies listed on the S&P and the 50 ASX companies. Using the CAPM model, they first predicted the annual expected return of each stock. Then, geometric Brownian motion was used once for individual stocks and once for composite portfolios in different states. Three methods of correlation coefficient, MAPE, and percentage of predictions in the correct direction were used to examine the prediction accuracy. The results revealed that although based on the MAPE criterion, the prediction of periods of 1 week, 2 weeks, 1 month, 2 months, and one year is done optimally, the lowest prediction error was obtained in the periods of 1 week, 2 weeks, and 1 month. After that, as the prediction time horizon increases, the error values increase.

Agustini et al. (2018) conducted a study entitled "Stock price predicting using geometric Brownian motion". Based on the geometric Brownian motion model, they predicted the stock prices of 7 companies in the combined index of the Jakarta Stock Exchange. Using the MAPE criterion to examine the accuracy of the predicted values, they showed that the geometric Brownian motion model has a high rank in the prediction with high accuracy so the MAPE value for the smaller predicted values was 20%. Tran and Leirvik (2019) examined the efficiency of the cryptocurrency market. This study revealed that the level of market returns in the five major cryptocurrencies is highly variable. Before 2017, cryptocurrency markets were mostly inefficient. However, the cryptocurrency market became more efficient during 2017-2019. The results also showed that Litecoin is the most efficient cryptocurrency, while Ripple is the least efficient. Rutkovuska et al. (2022) obtained negative, positive, and statistically significant premiums using stock and portfolio data from the UK as data. The results revealed that D-CPM (downside beta coefficients) is not useful in asset pricing less than CAPM (normal beta coefficients). Investors in downside risk are rewarded with higher premiums than those investing in normal beta risk.

Review of domestic literature

Using the data collected from the Tehran Stock Exchange, Yousefi, Tavakkoli Baghdadabad, and Nafar (2009) investigated the impact of negative systematic risk in the multi-factor model of capital asset pricing. By explaining the D-CAPM multi-factor model, they compared this model with the multi-factor model A CAPM. In the mentioned study, after calculating the D-CAPM model in comparison with the CAPM model, a relationship between risk and return was shown. Also, the portfolio resulting from the mentioned model was more efficient compared to the portfolio resulting from the CAPM model.

Tavangar and Khosraviani (2011) reviewed the information related to the price and return of the mentioned currencies from 2018 to 2021 daily. In the stock market, stock returns are predicted using both models and compared with real returns. Results showed that the D-CAPM model has worked much more efficiently regarding the match of the predicted values with the actual values with a better expression of the relationship between risk and return compared to the traditional CAPM model. Owhadi and Taj (2018) showed that the historical beta model has a very low estimate of Bitcoin returns in all periods. The adjusted beta model showed very different results with the most accurate estimate in a year. The reason why the adjusted beta shows more promising results is probably due to the shorter period and Bitcoin's volatility, making CAPM show better results.

II. METHODOLOGY

Statistical population and sample

The statistical population of the study included fifty cryptocurrencies that were studied as a representative of risky assets during the five years from 2018 to 2022 with daily frequency. Using the conditional variance test, eighteen cryptocurrencies were accepted and the rest of were homogeneously rejected in the variance heterogeneity test.

Eighteen cryptocurrencies include eight high-risk cryptocurrencies, six low-risk cryptocurrencies, and four cryptocurrencies with moderate variance. Finally, nine cryptocurrencies, which included various types of variance, were selected as portfolios. Cryptocurrencies with the highest value in the market are considered as statistical samples in the target population. The studied cryptocurrencies are Bitcoin, Ethereum, Ripple, Bitcoin Cash, and EOS.

Research hypotheses

Hypothesis 1: In the periods when the market risk premium is positive, the D-CAPM model will have more explanatory power compared to the CAPM model.

Hypothesis 2: In the periods when the market risk premium is negative, the D-CAPM model will have more explanatory power compared to the CAPM model.

Model of the method of measuring the research variables

The method of this study is descriptive and based on library documents, followed by statistical tests. In this study, to review the literature, the available documents including articles, scientific books, and official statistical data published are first used. Then, to infer and test the hypotheses and answer the research questions, the desired statistical information is collected and processed from the published documents by the statistics and information-generating devices. The R software will be used in this study. The statistical population of the present study includes nine cryptocurrencies including Bitcoin, Ethereum, Binance, DOGE, Cardona, Polygon MATIC, UNUS SED LEO, and XRP indices from 2018 to 2022 based on daily data. Finally, we examine the accuracy of the expected return compared to the actual return in the capital asset pricing model and the downside capital asset pricing model (D-CAPM). In this study, authentic data from the Coinmarketcap.Com and Tradingview.Com sites were used.

III. DATA ANALYSIS

First portfolio

In this study, different cryptocurrencies were examined based on different methods, and 9 low-risk, moderate-risk, and high-risk cryptocurrencies were selected. Then, using different methods, the panel nature of the data was investigated using Levin-Lin, Chu, IM-Pesaran-Shin, and Dickey-Fuller tests. The results revealed that the panel model was suitable for these data. This result was normal considering the non-homogeneity of cryptocurrencies at the time of selecting them (Table 1).

Table 1. *Examining the appropriateness of the panel model*

Test	Test statistic value	Test significance	Conclusion
LLC	-43.438	<0.001	The panel model is appropriate
IPS	-48.208	<0.001	The panel model is appropriate
ADF	403.19	<0.001	The panel model is appropriate

Now, using the relationships stated before, we examine the CAPM and DCAPM models. For this purpose, we first examined whether the volatilities detected in the general state are significantly different from the unfavorable state or not. For this purpose, the paired t-test was used (Table 2).

Table 2. *Pairwise comparison of CAPM and D-CAPM*

Examined pair	Mean	SD	T statistic	df	Sig.	Conclusion
difference of expected efficiency in CAPM and DCAPM models			20.218	2834	0.001	There is a significant difference

Now, using the stated relationships, the fit of two CAPM and DCAPM models is examined. In this regard, since the goal of the study is to identify the appropriateness of the model, the R^2 criterion for description and the GLT test were used. The results of this investigation are as follows. As shown, the two models are not significantly different in this portfolio. (Table 3).

Table 3. *Examining the significant difference between two the models*

Model	R2 value	Model error level	Model appropriates	GLT test statistic	Df1	Df2	Sig	Conclusion
CAPM	0.96	0.1453	Appropriate	0.3654	1	8	0.46	the two models are not significantly different
DCAPM	0.99	0.1636	Appropriate					

Second portfolio

In this study, different cryptocurrencies were examined based on different methods. Cryptocurrencies (cryptocurrencies including Bitcoin, Ethereum, Binance, DOGE, Cardona, Polygon MATIC, UNUS SED LEO, and ERP XRP) were selected as low-risk, moderate-risk, and high-risk. Then, using different methods, the panel nature of data was investigated using Levin-Lin, Chu, IM-Pesaran-Shin, and Dickey-Fuller tests. The results revealed that the panel model was appropriate for these data. This result was normal considering the non-homogeneity of cryptocurrencies at the time of selecting them (Table 4).

Table 4. *Examining the appropriateness of the panel model*

Test	Test statistic value	Test significance	Conclusion
LLC	-41.352	<0.001	The panel model is appropriate
IPS	-59.356	<0.001	The panel model is appropriate
ADF	1003.54	<0.001	The panel model is appropriate

Now, using the relationships stated before, we examine the CAPM and DCAPM models. For this purpose, we first examined whether the volatilities detected in the general state are significantly different from the unfavorable state or not. For this purpose, the paired t-test was used (Table 5).

Table 5. *Examining the appropriateness of the research subject for the selected portfolio*

Examined pair	Test statistic value	df	Sig.	Conclusion
difference of efficiency in CAPM and DCAPM models	35.256	22834	<0.001	Significant difference

Now, using the stated relationships, the fit of two CAPM and DCAPM models is examined. In this regard, since the goal of the study is to identify the appropriateness of the model, the R^2 criterion for description and the GLT test were used. The results of this investigation are as follows. As shown, the D-CAPM model can justify the behavior of cryptocurrencies significantly better than the CAPM model (Table 6).

Table 6. *Examining the significant difference between two the models*

Model	R2 value	Model error level	Model appropriates	GLT test statistic	Df1	Df2	Sig	Conclusion
CAPM	0.91	0.13265	Inappropriate	25.365	1	8	0.001	DCAPM model is significantly better than CAPM.
DCAPM	0.99	0.05639	Appropriate					

Third portfolio

In this study, different cryptocurrencies were examined based on different methods. Cryptocurrencies (cryptocurrencies including Bitcoin, Shiba, Solana, Binance, Dodge, Cardona, Polygon MATIC, UNUS SED, LEO, LEO, XRP, and XRP) were selected as low-risk, moderate-risk, and high-risk. Then, using different methods, the panel nature of data was investigated using Levin-Lin, Chu, IM-Pesaran-Shin, and Dickey-Fuller tests. The results revealed that the panel model was appropriate for these data. This result was normal considering the non-homogeneity of cryptocurrencies at the time of selecting them (Table 7).

Table 7. *Examining the appropriateness of the panel model*

Test	Test statistic value	Test significance	Conclusion
LLC	-41.336	<0,001	The panel model is appropriate
IPS	-58.352	<0,001	The panel model is appropriate
ADF	998.1	< 0.001	The panel model is appropriate

Now, using the relationships stated before, we examine the CAPM and DCAPM models. For this purpose, we first examined whether the volatilities detected in the general state are significantly different from the unfavorable state or not. For this purpose, the paired t-test was used (Table 8).

Table 8. *Examining the appropriateness of the research subject for the selected portfolio*

Examined pair	Test statistic value	df	sig	Conclusion
difference of efficiency in CAPM and DCAPM models	33. 712	10384	<0.001	Significant difference

Now, using the stated relationships, the fit of two CAPM and DCAPM models is examined. In this regard, since the goal of the study is to identify the appropriateness of the model, the R^2 criterion for description and the GLT test were used. The results of this investigation are as follows. As shown, the D-CAPM model can justify the behavior of cryptocurrencies significantly better than the CAPM model (Table 9).

Table 9. *Examining the significant difference between two the models*

Model	R2 value	Model error level	Model appropriates	GLT test statistic	Df1	Df2	Sig	Conclusion
CAPM	0.92	0.12521	appropriate	8.999	1	8	0.017	DCAPM model is significantly better than CAPM
D-CAPM	0.92	0.10562	appropriate					

The error level of the D-CAPM model was significantly lower.

IV. CONCLUSION

The results revealed that the D-CAPM model, in comparison with the CAPM model, shows the relationship between risk and return appropriately, and the portfolio resulting from the D-CAPM model is more efficient in comparison with the portfolio resulting from the CAPM model. The users of this study include investors who only have cryptocurrency portfolios. In the first portfolio that included 9 cryptocurrencies, both models are appropriate for fitting, but the returns have a significant difference. In the second portfolio, the cryptocurrency of the D-CAPM model is significantly better than the CAPM model since the error level of the D-CAPM model was significantly lower. In the third portfolio which includes 9 cryptocurrencies (Bitcoin, Ethereum, Binance, DOGE, Cardona, Polygon MATIC, UNUS SED LEO, and XRP XRP), the D-CAPM model was significantly better than the CAPM model since the error level of the D-CAPM model was significantly lower. Thus, the D-CAPM model is a more appropriate model than the CAPM model.

V. REFERENCES

[1] Estrada, J. (2002). Systematic risk in emerging markets: The DCAPM. *Emerging Markets Review*, *3*(4), 365-379.

[2] Fama, E. F., & Ferench, K. R. (1992). The cross-section of expected stock returns. *The Journal of Finance*, *47*, 427-465.

[3] Owhadi, F., & Taj, Y. (2018). Using cryptocurrency and the risks of investing in it. In: *The fifth national conference on applied research in management and accounting.*

[4] Raei, R., & Saeidi, A. (2016). *Fundamentals of Financial Engineering and Risk Management.* 2nd ed. Semat Publications.

[5] Rahnemay-e Roodposhti, F., Nikoo Maram, H., & Shahverdiani, Sh. (2006). *Strategic Financial Management (Value Creation).* Kasa Kavosh Publications.

[6] Tavangar, A., & Khosraviani, M. (2011). Testing D-CAPM model power in comparison with CAPM model in explaining the relationship between stock risk and return. *Financial Knowledge of Securities Analysis*, *9*, 25-42.

[7] Yousefi, M. G., Tavakkoli Baghdadabad, M. R., & Nafar, H. (2009). Examining the capital asset pricing model with D-CAPM to compare risk and return in the Tehran securities market. *Economic Research Journal*, *5*, 123-95.

[8] Bayat, R., Commercial management and international trade with the approach of earning financial income, 6th National Conference of Applied Research in Management, Accounting and Healthy Economy in Banking, Stock Exchange and Insurance, Tehran, 2020.

[9] Tehrani, R (2006), (Financial Management), Negahe Danesh Publications.

[10] Shojaei, A, and Heydarzadeh Hanzaei, A, 2021, Predicting cryptocurrency return using two approaches, geometric Brownian motion and wavelet transforms, https://civilica.com/doc/1240853

[11] Shahvardiani, Sha, (2006), "Examining and explaining the CAPM-D supplementing the CAPM to calculate the rate of return on shares of investment companies listed on the Tehran Stock Exchange". Master's Thesis, Islamic Azad University, Central Tehran Branch, supervised by Dr. Rahnamaye Roodposhti.

[12] Sayyad Marouf, MR; Siedi, SH; Andalib, A, Bitcoin security and its challenges, the third international conference on recent innovations in electrical and computer engineering, Tehran, Iran, 2016

[13] Abbasian, A., Rahnamaye Roodposhti, F., Tavakoli Baghdadabadi, M. (2006). Examining the function of the pricing technique of downside capital assets in the Tehran securities market. Financial Research Quarterly Journal.
[14] Nikoo Maram, H and Rahnamaye Roodposhti, F, and Haibti, F (2006), "Dictionary of specialized financial terms", Islamic Azad University Publications, Science and Research Unit.
[15] Nikoo Maram, Hashem and Rahnamaye Roodposhti, F, and Hibibi, F (2008), "Fundamentals of Financial Management", Volume II, Termeh Publications.
[16] Andrew Wagner, Digital vs. Virtual Currencies, retrieved Jan 27, 2015
[17] Anna Rutkowska-Ziarko , Lesław Markowski , Christopher Pyke , Saqib Amin (2022), "Conventional and downside CAPM: The case of London stock exchange", journal homepage: www.elsevier.com/locate/gfj.
[18] Black Market Bank Accused of Laundering $6B in Criminal Proceeds. Retrieved Jan 27, 2015.
[19] Black, Fischer. Michael C. Jensen. And Myron Scholes. (1971). The capital asset pricing model: Some empirical tests.in: M Jenson. Ed Studies in the theory of capital markets(Preager, New York, NY).
[20] Digital vs. Virtual Currencies. Andrew Wagner. Retrieved Jan 27, 2015.
[21] Hodson, H. (2014). "My Bitcoin road trip: living on virtual money for a day." New Scientist 221(2955): 22
[22] Stephan, C.Fan, (2004), "How We Misinterpreted CAPM For 40 Years? A Theoretical Proof"
[23] Nakamoto S. Bitcoin: A Peer-to-Peer Electronic Cash System, Www.Bitcoin.Org, 2008.
[24] Ayboğa, M. H., & Ganii, F. (2022). The Covid 19 crisis and the future of bitcoin in E-commerce. *Journal of Organizational Behavior Research*, *7*(2-2022), 203-213.
[25] Ngoc, H. D., Ngoc, T. N., & Le, H. A. (2022). Cash flow and external financing in the covid pandemic context and financial constraints. *Journal of Organizational Behavior Research*, *7*(2-2022), 109-119.
[26] Sadovnikova, N., Lebedinskaya, O., Bezrukov, A., & Davletshina, L. (2022). The correlation between residential property prices and urban quality indicators. *Journal of Advanced Pharmacy Education and Research*, *12*(2-2022), 98-103.
[27] Mirghaed, M. T., Karamaali, M., Bahadori, M., & Abbasi, M. (2022). Identification and Prioritization Technologies and Types of Threats in Future Warfare Using Future Studies Approach. *Entomology and Applied Science Letters*, *9*(1-2022), 7-19.